

REMARKS

Claims 1, 16, 44, 45 and 48 have been amended. Claims 1-8, 16-20, 40-46, 48, 49 and 50 are pending in the application. The specification has also been amended. No new matter has been introduced by the amendments.

Paragraph [0030] of the specification was slightly amended for agreement between the first and third sentences of the paragraph. As explained in the third sentence, “[b]y compensating for the charge associated with the dangling bonds, the resulting pixel cell 100 has *decreased* current generation and/or current leakage and, therefore, suppressed dark current.” Therefore the “halogen-rich region 34 *reduces* the effects of current generation or current leakage found in conventional pixel cells.” Applicant respectfully submits that no new matter has been introduced by the amendment.

Claims 1-4, 6-8, 16-20, 40, 44, 45, 46, 48, and 49 stand rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,780,666 (McClure) (or Applicant’s Prior Art) in view of U.S. Patent No. 6,211,040 (Liu). The rejection is respectfully traversed.

At the outset, it is noted that the present application (‘152 Application) has a filing date of September 3, 2003 and that McClure is only a reference under 35 U.S.C. §102(e) based on a filing date of August 7, 2003. Since McClure and the present invention were under an obligation of assignment to the same entity, Micron Technology, Inc., as evidenced by the attached assignments, McClure is not a §103(a) reference pursuant to §103(c). Accordingly, this rejection is treated as a rejection based on the admitted prior art in view of Liu.

The present invention is directed to an imaging device pixel cell having a halogen-rich region formed therein for suppressing dark current in a photosensor. Independent claim 1, as amended, recites a pixel cell having “a photosensor having a first doped region and a second doped region in association with a semiconductor substrate, said photosensor capable of generating dark current; [and] an isolation region formed within said substrate and adjacent to said photosensor.” Claim 1 further recites the pixel cell having “a halogen-rich region localized at least at a sidewall region of said isolation region, said halogen-rich region having a halogen concentration sufficient to suppress said dark current.”

Independent claim 16, as amended, recites a pixel cell having “a photosensor formed in said substrate and having a first doped region and a second doped region in association with said semiconductor substrate, said photosensor being capable of generating dark current; a halogen-rich region formed within at least one of said trenches, said halogen-rich region having a halogen concentration sufficient for the suppression of said dark current; and an isolation region formed within said at least one trench.”

Independent claim 44, as amended, recites a pixel cell having “a photosensor having a first doped region and a second doped region in association with a semiconductor substrate, said photosensor capable of generating dark current; a shallow trench isolation region formed within said substrate and adjacent to said photosensor; and a fluorine-rich region localized at a boundary between said shallow trench isolation region and said substrate, said fluorine-rich region having a depth from a surface of said substrate sufficient to suppress said generation of dark current.”

Independent claim 45, as amended, recites a pixel cell having “a photosensor having a first doped region and a second doped region in association with a semiconductor substrate; a shallow trench isolation region formed within said substrate; and a halogen-rich region localized throughout a surface of said substrate that contacts said shallow trench isolation region, said halogen-rich region having a halogen concentration sufficient for suppressing the flow of dark current from said photosensor.”

Independent claim 48, as amended, recites a pixel cell having “a photosensor having a first doped region and a second doped region in association with a semiconductor substrate; an isolation region formed within a trench formed within said substrate; and a halogen-rich region localized within said trench, said halogen-rich region having a halogen concentration sufficient for suppressing the presence of charge collecting dangling bonds of said substrate at said trench.”

Applicant’s Admitted Prior Art (APA) relates to a conventional pixel cell. *See* ‘152 Application at [0005]. Conventional pixel cells typically silicon-based substrates, which have trenches. *Id.* at [0008]. The trenches are typically filled with a dielectric resulting in a shallow

trench isolation (STI) having a boundary with the silicon-based substrate. *Id.* The STI boundaries, however, create higher density “trap sites” that trap electrons or holes. *Id.* at [0009]. The trapped electrons or holes result in current generation, which results in dark current (or electrical current in the photosensor in the absence of light). *Id.* at [0009]-[0010]. The present invention improves upon the APA by suppressing dark current by reducing the effects of current generation or current leakage found in conventional pixel cells. *Id.* at [0030].

Liu relates to a two-step, low argon, DHP CVD oxide deposition process. Liu (Title). Specifically, Liu relates to a method for depositing silicon dioxide, wherein “the argon gas flow is dramatically lower than that of the prior art process.” Liu at col. 4:12-13. Liu discloses metal traces 48 formed above an isolation layer 44 that is formed above the semiconductor substrate 40. Liu at col. 3:49-55. According to Liu, a liner layer 52 is formed *above* the metal traces 48 by a claimed process. *Id.* at col. 4:2-5.

The process uses a gas mixture of silane, oxygen, and argon. The preferred gas mixture is comprised of silane flowing at of between about 60 sccm and 100 sccm, oxygen flowing at between about 90 sccm and 150 sccm, and argon flowing at between about 40 sccm and 80 sccm. The argon gas constitutes between about 14% and 35% of the total pressure of the chamber. Note that the argon gas flow is dramatically lower than that of the prior art process.

The reduced argon flow results in a very low-pressure environment for the plasma. The pressure is preferably less than about 2 milliTorr. This low plasma pressure reduces the silicon oxide deposition rate on the sidewalls of the gaps.

Liu at col. 4:6-17.

The Office Action attempts to combine Liu with APA to allegedly arrive at the claimed invention. Courts have generally recognized that a showing of a prima facie case of obviousness necessitates three requirements: (i) some suggestion or motivation, either in the references themselves or in the knowledge of a person of ordinary skill in the art, to modify the reference or combine the reference teachings; (ii) a reasonable expectation of success; and (iii) the prior art references must teach or suggest all claim limitations. *See e.g., In re Dembiczak*, 175 F.3d 994 (Fed. Cir. 1999); *In re Rouffet*, 149 F.3d 1350, 1355 (Fed. Cir. 1998); *Pro-Mold & Tool Co. v. Great Lakes Plastics, Inc.*, 75 F.3d 1568, 1573 (Fed. Cir. 1996); and MPEP §§ 706.02(j) and 2143 *et seq.* Furthermore, the “[t]he teaching or suggestion to make the

claimed combination and the reasonable expectation of success must both be found in the prior art and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991)." MPEP §706.02(j).

The Office Action fails to provide a *prima facie* showing that either the reference cited (Liu) or the knowledge of a person of ordinary skill in the art provide some suggestion or motivation to modify the reference or combine the reference teachings as required by MPEP §§706.02(j) and 2143 *et seq.*

Specifically, there is no motivation to combine Liu (a reference disclosing a process of forming a liner *above* metal lines) with APA (a reference provided by Applicant discussing the problems associated with current generation by a photosensor that is in association with a *semiconductor substrate*). Liu and APA relate to two completely different levels in the manufacturing process of a semiconductor device; therefore, Applicant respectfully submits that there is no motivation, either in the references themselves or in the knowledge of a person of ordinary skill in the art, to combine Liu with APA, and the two references are *not* properly combinable.

Even if the Liu could be combined with APA, which it cannot, Liu and APA, alone or in combination, fail to teach or suggest each and every limitation of claim 1. Significantly, Liu and APA, alone or in combination, fail to disclose, teach, or suggest a photosensor having "a first doped region and a second doped region in association with a semiconductor substrate, said photosensor capable of generating dark current; an isolation region formed within said substrate and adjacent to said photosensor; and a halogen-rich region localized at least at a sidewall region of said isolation region, said halogen-rich region having a halogen concentration sufficient to suppress said dark current," as recited by independent claim 1.

Claim 16 is also not rendered obvious by Liu and APA. As discussed above with respect to claim 1, Liu and APA, alone or in combination, fail to disclose, teach, or suggest suppressing dark current, as recited by the claimed invention. Accordingly, APA, alone or in combination with Liu, fails to disclose, teach, or suggest a pixel cell having "a photosensor formed in said substrate and having a first doped region and a second doped region in association with said semiconductor substrate, said photosensor being capable of generating dark

current; a halogen-rich region formed within at least one of said trenches, said halogen-rich region having a halogen concentration sufficient for the suppression of said dark current; and an isolation region formed within said at least one trench,” as recited by claim 16.

Claim 44 is also not rendered obvious by the cited references. As discussed above with respect to claim 1, Liu and APA, alone or in combination, fail to disclose, teach, or suggest suppressing dark current, as recited by the claimed invention. Accordingly, APA, alone or in combination with Liu, fails to disclose, teach, or suggest a pixel cell having “a photosensor having a first doped region and a second doped region in association with a semiconductor substrate, said photosensor capable of generating dark current; a shallow trench isolation region formed within said substrate and adjacent to said photosensor; and a fluorine-rich region localized at a boundary between said shallow trench isolation region and said substrate, said fluorine-rich region having a depth from a surface of said substrate sufficient to suppress said generation of dark current,” as recited by claim 44.

Claim 45 is also not rendered obvious by the cited references. As discussed above with respect to claim 1, Liu and APA, alone or in combination, fail to disclose, teach, or suggest suppressing dark current, as recited by the claimed invention. Accordingly, APA, alone or in combination with Liu, fails to disclose, teach, or suggest a pixel cell having “a photosensor having a first doped region and a second doped region in association with a semiconductor substrate; a shallow trench isolation region formed within said substrate; and a halogen-rich region localized throughout a surface of said substrate that contacts said shallow trench isolation region, said halogen-rich region having a halogen concentration sufficient for suppressing the flow of dark current from said photosensor,” as recited by claim 45.

Claim 48 is also not rendered obvious by the cited references. As discussed above with respect to claim 1, Liu and APA, alone or in combination, fail to disclose, teach, or suggest suppressing dark current, as recited by the claimed invention. Accordingly, APA, alone or in combination with Liu, fails to disclose, teach, or suggest a pixel cell having “a photosensor having a first doped region and a second doped region in association with a semiconductor substrate; an isolation region formed within a trench formed within said substrate; and a halogen-rich region localized within said trench, said halogen-rich region having a halogen

concentration sufficient for suppressing the presence of charge collecting dangling bonds of said substrate at said trench," as recited by claim 48.

Accordingly, Applicant respectfully submits that independent claims 1, 16, 44, 45, and 48 are allowable over the combination of APA and Liu. Dependent claims 2-8, 17-20, 40-43, 46, 49, and 50 depend from independent claims 1, 16, 44, 45, and 48, and are allowable for at least the reasons set forth above, and on their own merit.

In view of the above amendment, applicant believes the pending application is in condition for allowance.

Dated: December 22, 2005

Respectfully submitted,

By 

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ASSIGNMENT AND AGREEMENT

For value received, I, Brent A. McClure, hereby sell, assign and transfer to Micron Technology, Inc., a corporation of the State of Delaware, having an office at 8000 S. Federal Way, Boise, Idaho 83706-9632, U.S.A., and its successors, assigns and legal representatives, the entire right, title and interest, for the United States of America, in and to certain inventions related to an invention entitled AN IMAGER PHOTO DIODE CAPACITOR STRUCTURE WITH REDUCED PROCESS VARIATION SENSITIVITY, described in an application for Letters Patent of the United States, executed by me of even date herewith, and all the rights and privileges in said application and under any and all Letters Patent that may be granted in the United States for said inventions; and I also concurrently hereby sell, assign and transfer to Micron Technology, Inc. the entire right, title and interest in and to said inventions for all countries foreign to the United States, including all rights of priority arising from the application aforesaid, and all the rights and privileges under any and all forms of protection, including Letters Patent, that may be granted in said countries foreign to the United States for said inventions.

I authorize Micron Technology, Inc. to make application for such protection in its own name and maintain such protection in any and all countries foreign to the United States, and to invoke and claim for any application for patent or other form of protection for said inventions, without further authorization from me, any and all benefits, including the right of priority provided by any and all treaties, conventions, or agreements.

I hereby consent that a copy of this assignment shall be deemed a full legal and formal equivalent of any document which may be required in any country in proof of the right of Micron Technology, Inc. to apply for patent or other form of protection for said inventions and to claim the aforesaid benefit of the right of priority.

I request that any and all patents for said inventions be issued to Micron Technology, Inc. in the United States and in all countries foreign to the United States, or to such nominees as Micron Technology, Inc. may designate.

I agree that, when requested, I shall, without charge to Micron Technology, Inc. but at its expense, sign all papers, and do all acts which may be necessary, desirable or convenient in connection with said applications, patents, or other forms of protection.

Brent A. McClure
Brent A. McClure

Date: 7/23/03

United States of America)
State of Idaho) ss.:
County of Ada)

On this 23rd day of July, 2003, before me personally came Brent A. McClure, to me known to be the individual described in and who executed the foregoing instrument, and acknowledged execution of the same.

Monica Keeling
Notary Public



ASSIGNMENT AND AGREEMENT

For value received, I, Chandra Mouli, hereby sell, assign and transfer to Micron Technology, Inc., a corporation of the State of Delaware, having an office at 8000 S. Federal Way, Boise, Idaho 83706-9632, U.S.A., and its successors, assigns and legal representatives, the entire right, title and interest, for the United States of America, in and to certain inventions related to an invention entitled SUPPRESSION OF DARK CURRENT IN A PHOTODIODE FOR IMAGING, described in an application for Letters Patent of the United States, executed by me of even date herewith, and all the rights and privileges in said application and under any and all Letters Patent that may be granted in the United States for said inventions; and I also concurrently hereby sell, assign and transfer to Micron Technology, Inc. the entire right, title and interest in and to said inventions for all countries foreign to the United States, including all rights of priority arising from the application aforesaid, and all the rights and privileges under any and all forms of protection, including Letters Patent, that may be granted in said countries foreign to the United States for said inventions.

I authorize Micron Technology, Inc. to make application for such protection in its own name and maintain such protection in any and all countries foreign to the United States, and to invoke and claim for any application for patent or other form of protection for said inventions, without further authorization from me, any and all benefits, including the right of priority provided by any and all treaties, conventions, or agreements.

I hereby consent that a copy of this assignment shall be deemed a full legal and formal equivalent of any document which may be required in any country in proof of the right of Micron Technology, Inc. to apply for patent or other form of protection for said inventions and to claim the aforesaid benefit of the right of priority.

I request that any and all patents for said inventions be issued to Micron Technology, Inc. in the United States and in all countries foreign to the United States, or to such nominees as Micron Technology, Inc. may designate.

I agree that, when requested, I shall, without charge to Micron Technology, Inc. but at its expense, sign all papers, and do all acts which may be necessary, desirable or convenient in connection with said applications, patents, or other forms of protection.

V. Chandra
Chandra Mouli

Date: 8/22/03

United States of America)
State of Idaho) ss.:
County of Ada)

On this 22nd day of August, 2003, before me personally came Chandra Mouli, to me known to be the individual described in and who executed the foregoing instrument, and acknowledged execution of the same.

Stacy Summers
Notary Public

expires 09/28/06.

